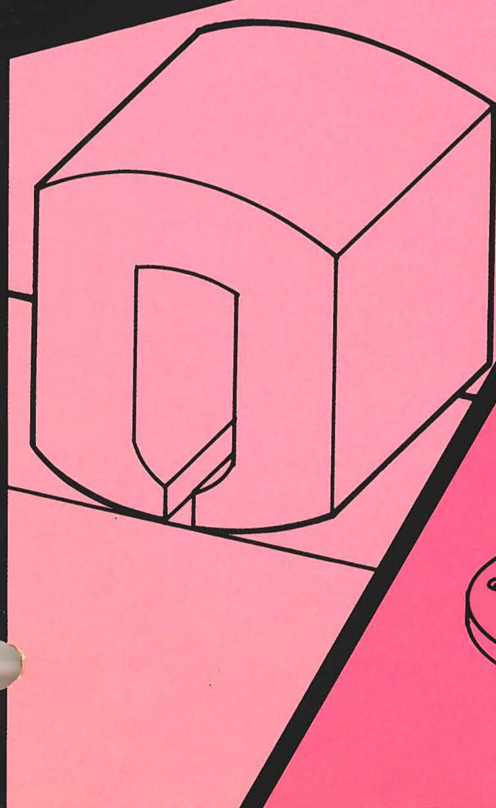
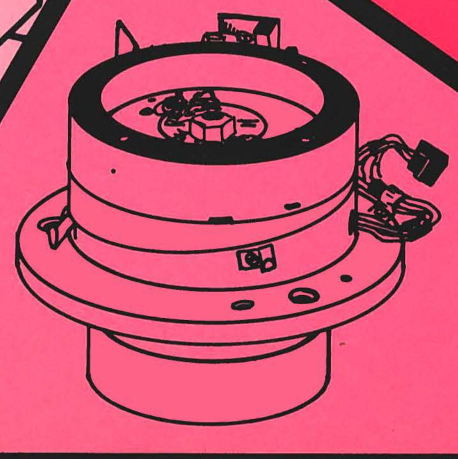
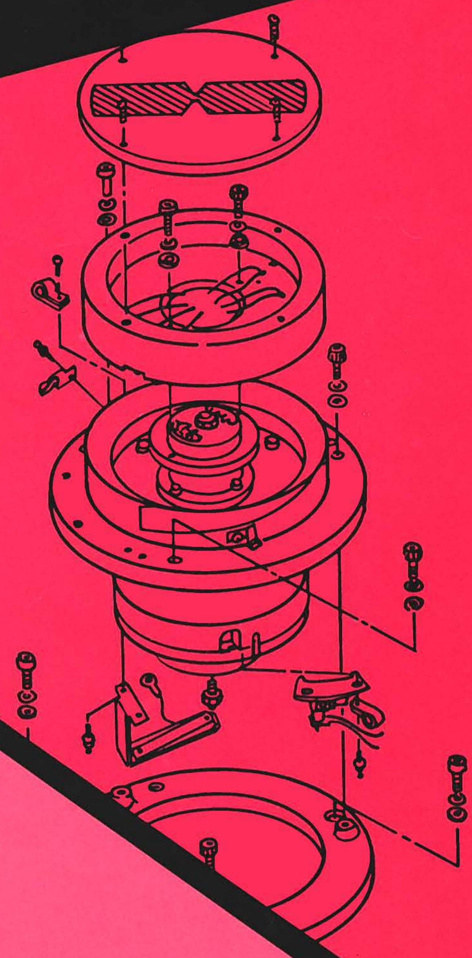
SONY BASIC VIDEO RECORDING COURSE
BOOKLET #3

SCANNER
SYSTEMS







SONY®

BASIC VIDEO RECORDING COURSE

BOOKLET 3

SCANNER SYSTEMS

Introduction

Tape Three introduced you to the basic 2-head scanner of the type used in U-matics, the Betamax, the EIAJ half-inch reel-to-reel formats and several other systems. In this booklet we will look into scanner systems using one, two and four video heads, and into other systems for guiding tape around the scanner. You will learn how to make basic writing-speed calculations from scanner dimensions, and see how the pulse generators, that provide servo-timing information, are constructed. Finally, you will see how the horizontal sync system of the TV set (or monitor) reacts to the timing errors produced by the VTR. You will see how the characteristics of the TV set affect the visual symptoms, caused by skew and dihedral errors.

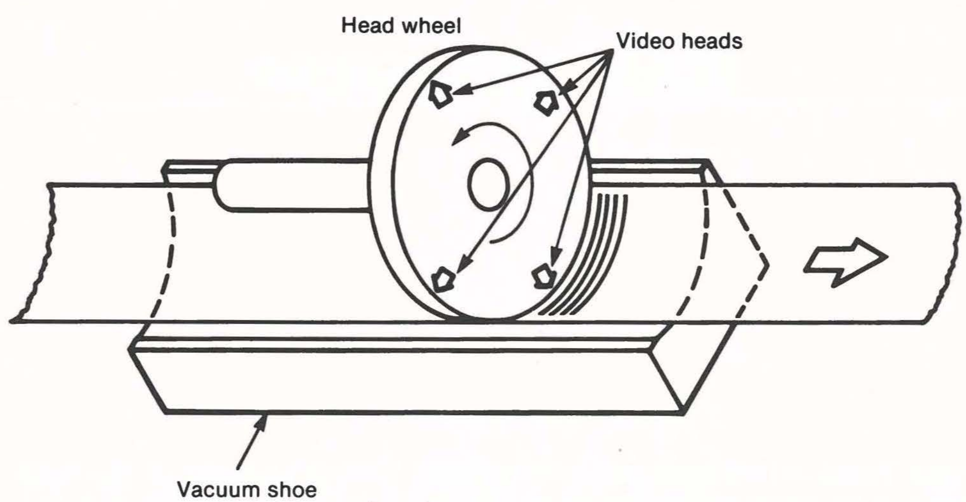


Fig. 1. Four-head segmented recorder.

1. SCANNER SYSTEMS

All video tape recorders that have met the test of production make use of one or more rotating video heads to achieve the required writing speed. These can be grouped into two fundamental classifications called *segmented* and *non-segmented* (or continuous).

Segmented Systems. The quadraplex studio tape recorders, long the mainstay of broadcast studio recording operations, is an example of a segmented recording system. High writing speed is achieved by breaking each TV frame up into a series of time intervals or segments, wherein each pass of a video head across the tape is a fraction of a field. Fig. 1 shows the basic system. Video FM is applied to four video heads mounted on a "head wheel." Each head is in contact with the tape for a little more than a quarter of a revolution and the 2-inch tape is shaped to conform to the radius of the head wheel by a "vacuum shoe."

The wheel spins at 240 revolutions per second so that it makes four complete revolutions in the time taken for one TV field. Each head is in contact with tape for a little more than a quarter turn so that there are 4 × 4 or 16 video-head passes in the time taken for a TV field. The field is segmented into 16 equal and sequential time intervals, and video head output is switched electronically during horizontal blanking to provide a continuous playback signal.

A more recent use of the segmented approach is found in the Bosh-Fernseh 1″ recorder. See Fig. 2. This system uses two video heads in a scanner that rotates at 90 revolutions per second. Each head is in contact with tape for a little more than a half turn. The scanner makes a full turn in 1/90th of a second and the active scan is half that time or 1/180th of a second. Each TV frame is therefore divided up into 6 segments of 1/180th of a second each. The advantage of the segmented system is high writing speed with relative small-diameter scanners. The speed is achieved with high rotation rates.

One disadvantage of the segmented approach is the inability to achieve slow-motion or still pictures easily. If the tape is stopped, the heads can playback only part of each segment. Slow and still pictures can be achieved only with the aid of external time-storage devices.

Non-Segmented Systems. The U-matic is an example of the non-segmented approach. In these systems, each swipe of a video head across the tape uses a time interval equal to that of a TV field (1/60th of a second). In some cases the active time of the swipe is somewhat shorter than the field duration and some fraction of the field (part of the vertical blanking interval) is sacrificed.

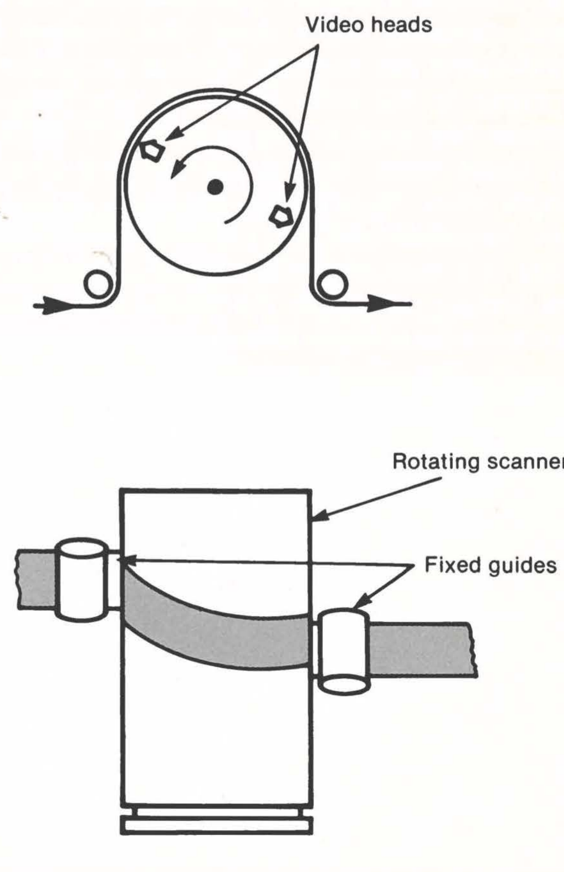


Fig. 2. Basic BCN scanner system.

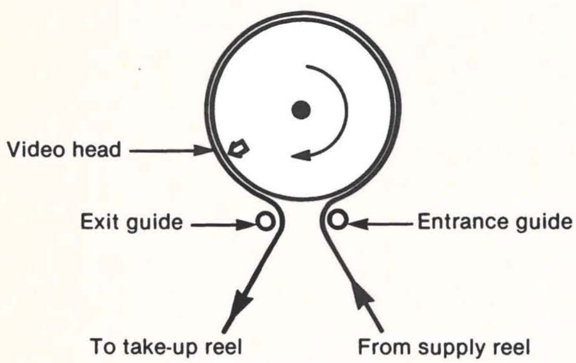


Fig. 3. Single-head scanner.

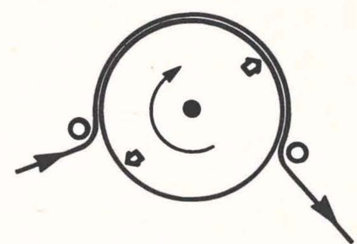


Fig. 5. Omega wrap used in two-head machine provides a wrap angle of slightly more than 180°.

Fig. 3 shows a system that uses only one video head mounted on a drum that rotates at 60 revolutions per second. Thus a complete turn is made in the time taken for one field. This system has been in use in Ampex 1″ machines for some time. During the interval when the single video head leaves the tape, at the location between the entrance and exit guides, there is a loss of signal, called a "dropout." In the Ampex machines the dropout duration is 7 to 8 horizontal lines and occurs during the vertical blanking interval. Figure 4 shows a waveform photo of this dropout. In some applications, the missing lines are restored using a processing amplifier.

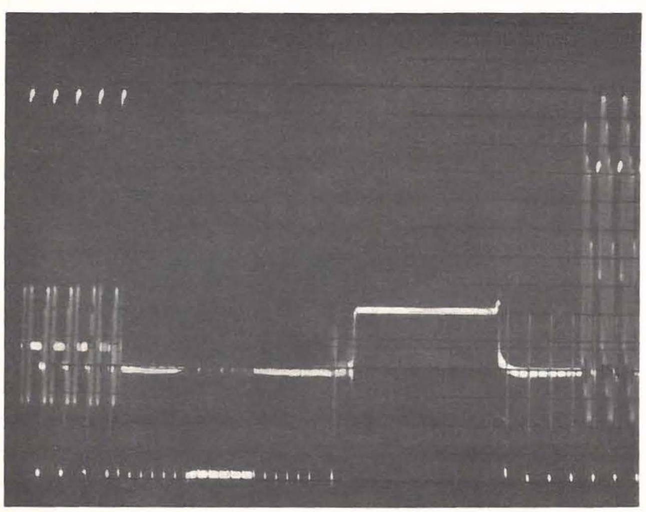


Fig. 4. Dropout in single-head machine occurs during vertical blanking.

Tape Wrap. The path taken by the tape in Fig. 3 as it flows around the scanner resembles the Greek letter omega (Ω), and this method of tape flow is called an "omega wrap".

The *wrap angle* refers to that part of the scanner where tape bears against the surface, as measured from the center of the scanner. For the single-head scanner shown in Fig. 3 the wrap angle is less than 360°. For the two-head machines shown in Fig. 5, the wrap angle is slightly more than 180° and the system is still referred to as an omega wrap.

Another approach to the single-head concept was taken in IVC machines. In this case an alpha wrap is employed, as shown in Fig. 6. Tape flows around the scanner in one continuous loop, much as a single turn of rope can be wrapped around a winch. Tape flow is quite natural and not subject to abrupt changes in direction at fixed entrance and exit guides, a factor that contributes to improved time-base stability.

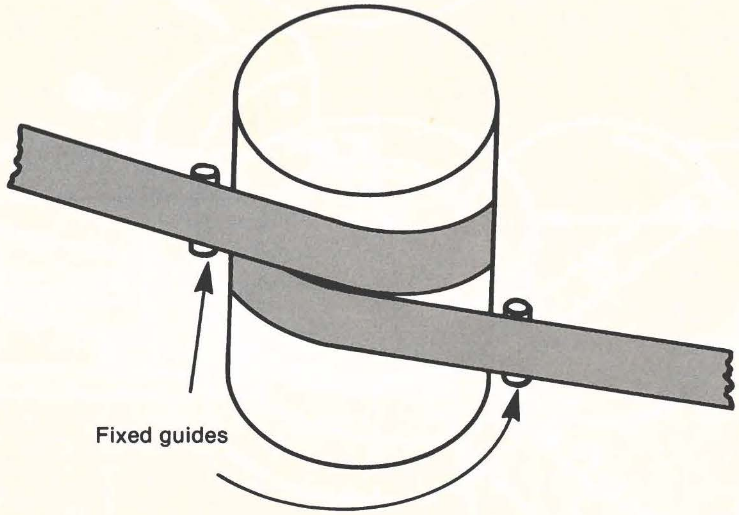


Fig. 6. Alpha wrap used with a single-head scanner.

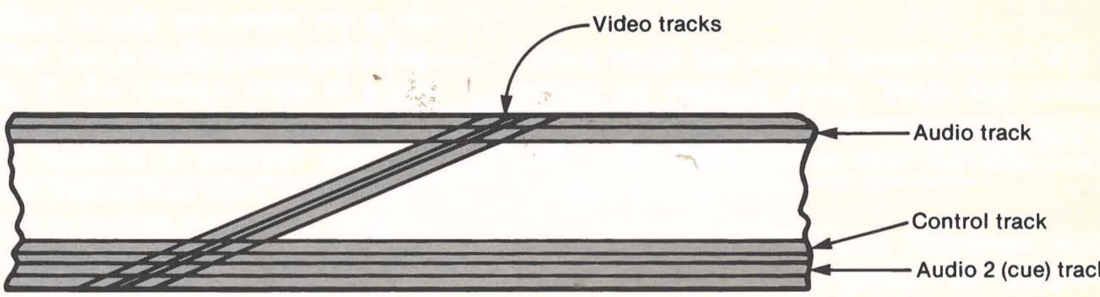


Fig. 7. IVC one-inch tape format.

In the IVC system, the video tracks occupy the full width of the tape, from edge to edge. See Fig. 7. Audio and control track signals are recorded at the input to the scanner on tracks near the top and bottom edges as shown. The video tracks are recorded over both audio and control tracks and isolation between video and audio (or control) is maintained by the difference in head azimuth between the tracks. Audio-and control-track heads have the gap azimuth at an angle of 25° to the long dimension of the tape. This coupled with an approximate 5° video track angle, yields an azimuth error of some 30° between video and both longitudinal tracks. This azimuth error is sufficient to maintain adequate isolation. As in other single-video-head systems, there is an interruption in signal when the head crosses the boundary between adjacent tape edges. The resulting drop out is arranged to occur during vertical blanking so that active video is undisturbed.

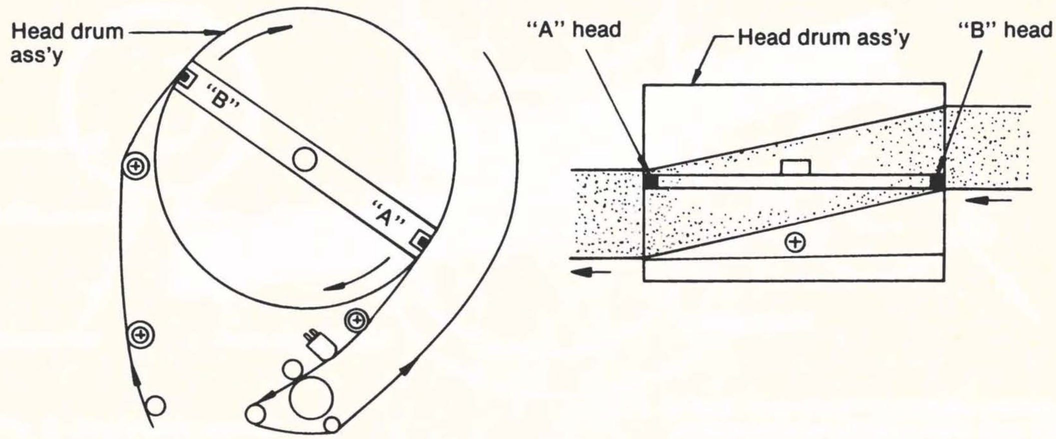


Fig. 8. U-matic scanner.

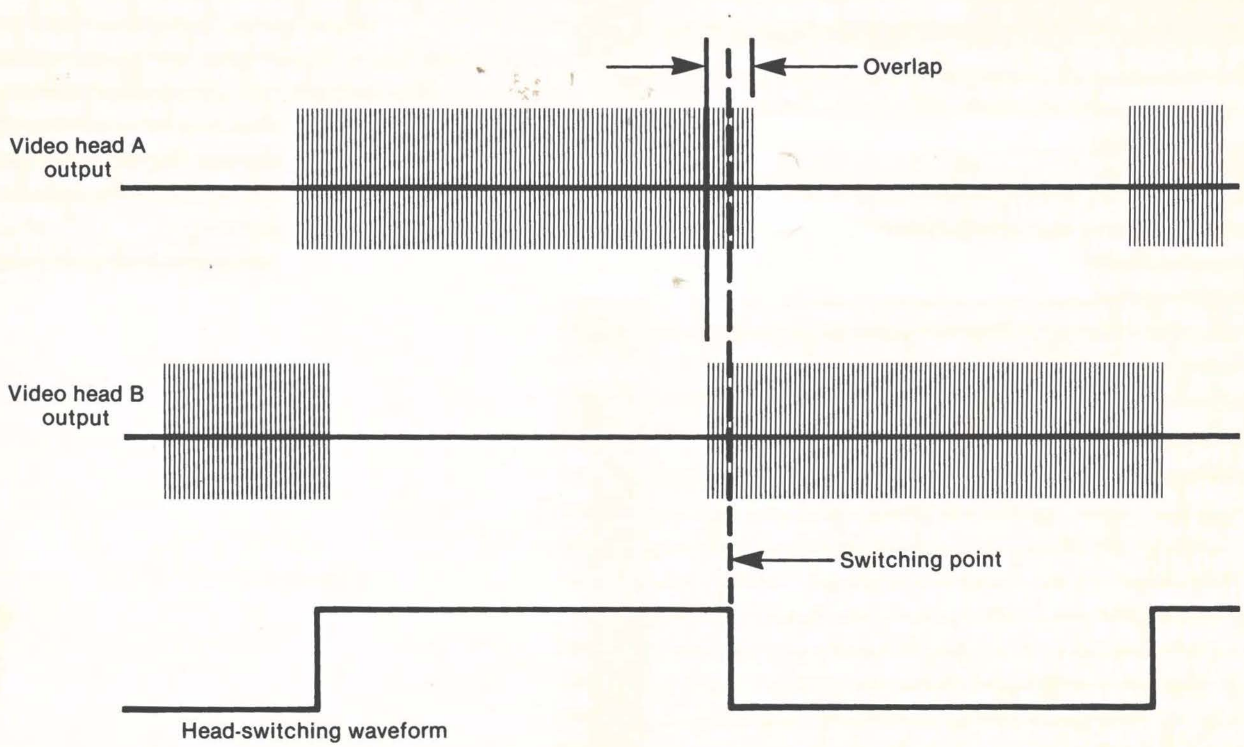


Fig. 9. Playback R-F envelopes for a two-head VTR.

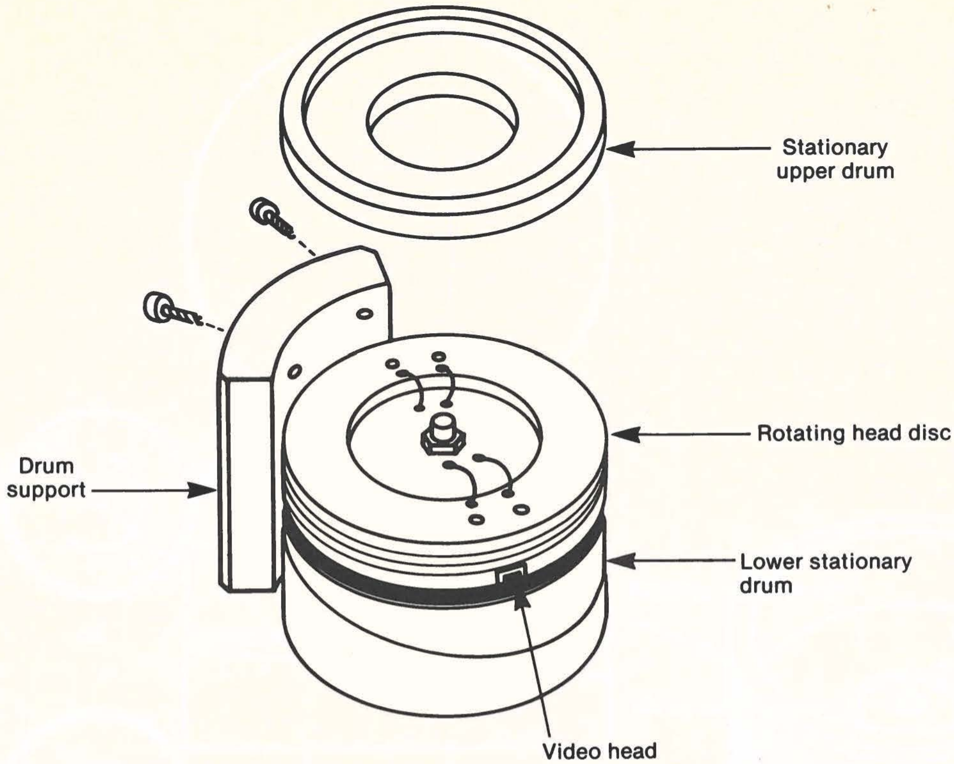


Fig. 10. Three-piece scanner with rotating central disc.

Two Head Systems. The scanner in the U-matic, Betamax and EIAJ ½-inch (AV series) employs two video heads mounted on a rotating member that turns at 30 revolutions per second. See Fig. 8. An omega wrap is used wherein the wrap angle is slightly more than 180°. Thus, each head is in contact with the tape for little more than a half turn, or 1/60th of a second. During the record mode, FM video is applied to both video heads in parallel. Because the wrap angle is greater than 180°, a brief period exists when both heads are in contact with the tape (one head just beginning its pass, the other just leaving) and an *overlap* interval occurs, during which the same video information is recorded on the end of one track and the beginning of the next. During playback, the video heads are separated and drive individual playback preamps. The r-f envelopes appear as shown in Fig. 9. Electronic switching occurs during the overlap interval to provide a continuous playback signal with no loss in video information. The overlap period extends three horizontal lines after the switching point for the head at the end of its pass and three lines ahead of the switching interval at the beginning of a track. Thus the total overlap period is about six horizontal lines.

Video head switching occurs about 6.5 lines ahead of vertical sync. Thus the switching point is visible in the picture about three and one half lines above the vertical blanking period.

Since the scanner in the two-head machine turns at half the speed of single-head machines, comparable writing speeds can be achieved only by increasing drum diameter.

Types of Scanners. Rotating scanners fall into two categories regarding their method of construction. In one type, the upper and lower parts of the drum or cylinder are stationary and the video heads are mounted on a relatively thin disc that rotates between the stationary members. See Fig. 10. This system is found in the EIAJ (AV series) machines, Betamax, and the early CV machines. Upper and lower stationary drums are held together by a heavy segment-shaped block at the rear of the scanner (opposite to the center of the tape wrap angle).

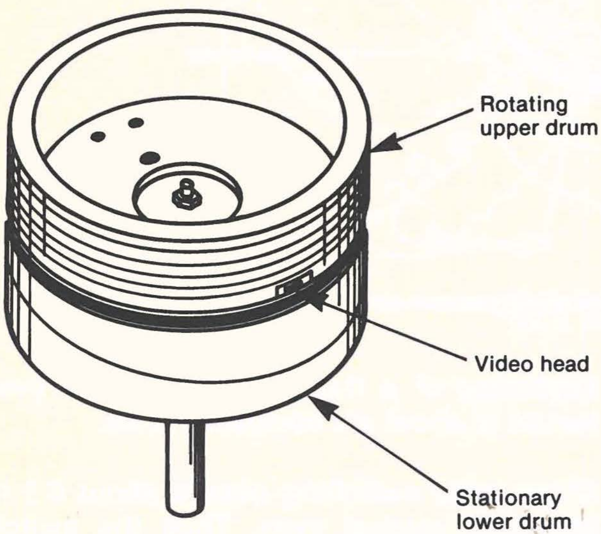


Fig. 11. Split drum with rotating upper half.

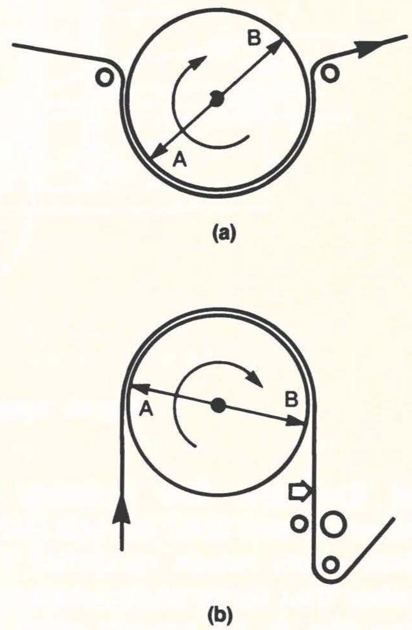


Fig. 12. Head rotation opposite to and in the same direction as tape travel.

In other systems, as represented by U-matic and Omega machines, the heads are mounted on the bottom surface of the upper drum; the entire upper drum rotates. See Fig. 11.

Drum-Rotation Direction. Another basic variation between systems is the direction in which the scanner rotates with respect to the direction of tape flow. In early machines (CV and AV), the heads rotate against the direction of tape movement. See Fig. 12(a). In the case of CV and AV the tape travels down around the scanner from supply to take up side. Thus the track starts at the upper edge and angles downwards towards the bottom edge. This method results in a slight increase in writing speed because tape and heads are moving in opposite directions. The track is also slightly longer when tape is moving and the track angle is shallower.

In later systems (U-matic, Betamax, Omega) the scanner turns in the opposite direction so that heads cross the tape in the same general direction as tape flow. See Fig. 12(b). Thus the track starts near the bottom of the tape and angles upwards. This system lowers friction due to the action of trapped air which builds in a thin layer between the drum and the tape. Writing speed is slightly lower, the track shorter when tape is moving, and the track angle gets slightly steeper when tape is moving. We will look into the effect on track angle and length more closely later in this booklet, and in booklet 4.

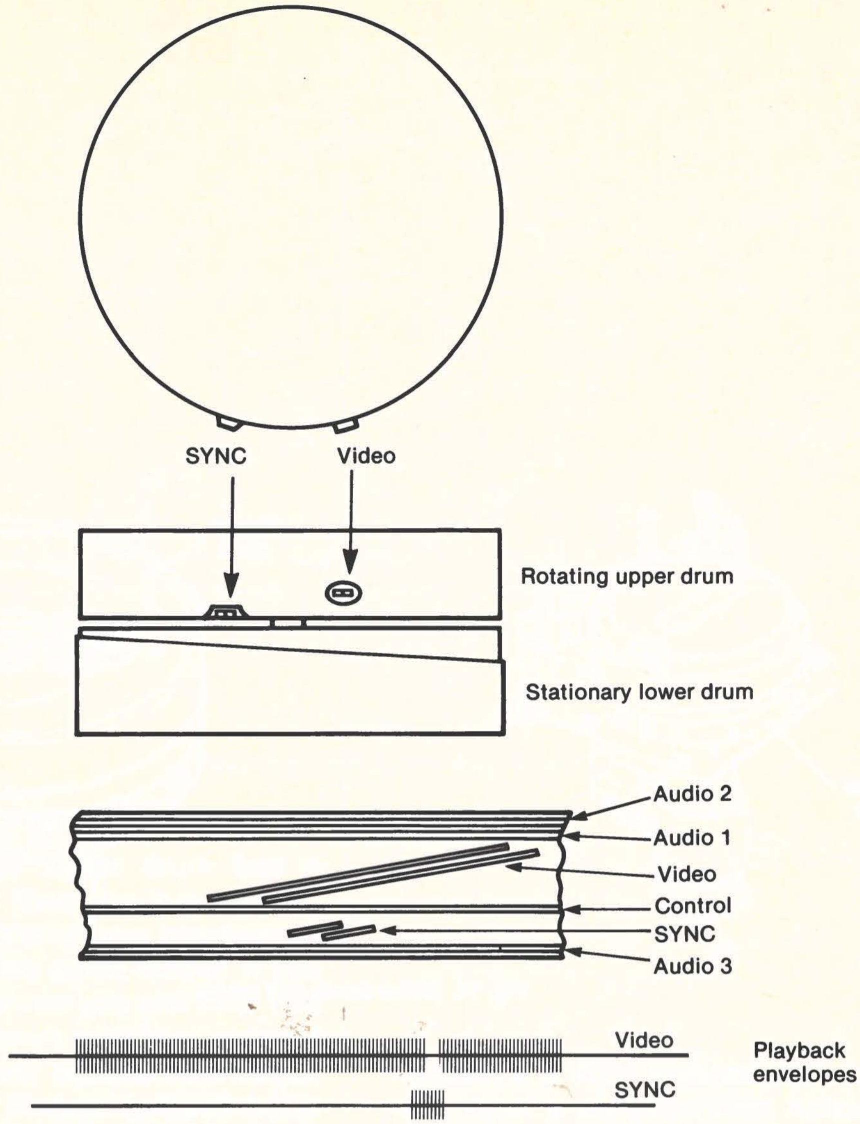


Fig. 13. Omega system employs 2 video heads but rotates at 60 rps.

1½-Head System. You have seen the trade off between 1 and 2-head non-segmented systems. Writing speed for the two-head system must be purchased at the expense of drum diameter. Machines have been made with very large drum diameters, but there are problems with stabilizing large rotating masses, and the longer video track lengths increases time base error due to skew and forms of longitudinal tape vibration.

A unique approach first applied in the SONY PV series and later in the first Omega machines achieves the writing speed/drum diameter of single-head machines without the loss of information resulting from the dropout. The system has been called the 1½ head scheme, which is a misnomer, as these are actually two identical video heads in the scanner. See Fig. 13. The scanner rotates at 60 revolutions per second with one head (called the *video* head) recording the entire active field plus the beginning and end of the vertical blanking period. The second video head (called the *sync* head) records the vertical blanking interval. An overlap is provided and electronic head switching is applied so that the playback signal is continuous and there is no loss of signal during the vertical blanking period.

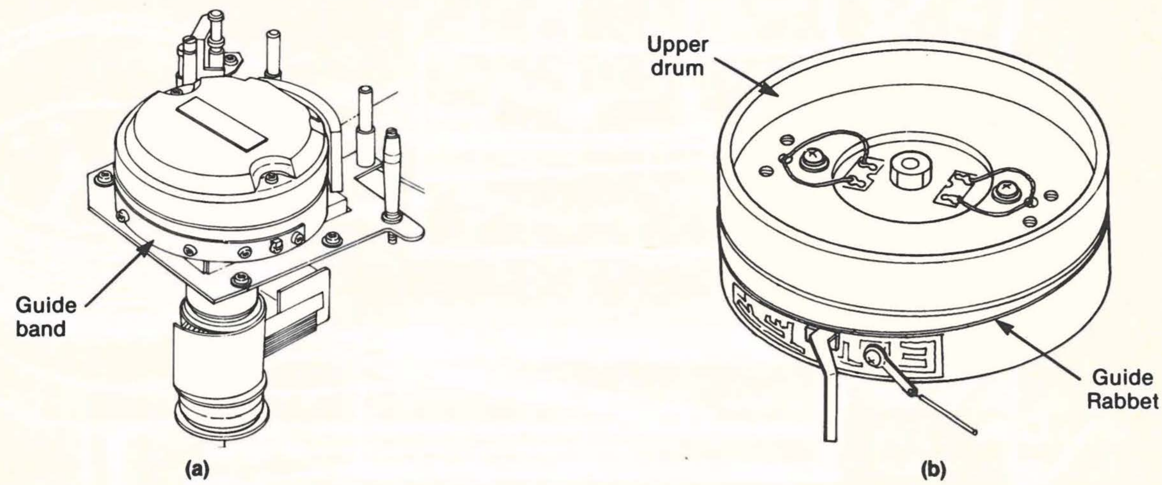


Fig. 14. Guide bands and rabbet.

Tape Guidance. The modern VTR is a masterpiece of precision machining on a large production scale. Of vital importance to the success of tape interchange between machines is the precision with which tape enters the tape path, flows around the scanner and moves towards the stationary heads. Tape is carefully guided using the lower edge as the reference. Stationary guides control tape height with respect to the scanner. Tape must change its direction and begin its downward flow at a stationary guide at the input side of the scanner. This guide, called the *entrance* guide is mounted at an angle or is tapered in form to alter the direction of tape flow. Its position with respect to the scanner is very critical as it determines the precise point at which tape comes into contact with the scanner, and affects such factors as the amount of recording overlap.

Tape flows around the scanner with its lower edge bearing against a sort of shelf on the lower drum surface. In early machines, the shelf was formed by a sheetmetal guide band, that is fastened to the lower drum surface. See Fig. 14(a). In later machines the shoulder is machined into the lower drum surface. See Fig. 14(b). The shelf or shoulder is called a *rabbet.*

As tape leaves the scanner its direction is changed once more by an angled or tapered exit guide. The entrance and exit guides, as well as the scanner rabbet, form the guidance system for tape. In some Sony machines the rabbet is not straight but has a microscopic deviation at the mid point to form a 3-point suspension system. The entrance and exit guides are always mounted on the casting that serves as the base for the scanner.

In some machines, the upper drum has a slightly larger diameter than the lower drum. This has the effect of forcing tape downwards so that it bears against the guide rabbet. If you look at the Betamax scanner you will note two spring-loaded plastic feelers near the center of the wrap angle that bear against the upper edge of tape to force it gently against the guide rabbet. See Fig. 15.

Great care must be taken to ensure that the entrance and exit guides are not disturbed. To realign the guides a standard tape must be played and the entire guidance system adjusted for a uniform (flat) r-f playback envelope. This is a trial-and-error procedure that requires much skill, time, and patience. Keep in mind that guides along the tape path can affect tape height or shape as tape enters or leaves the scanner area. The tape-tension guide is somewhat vulnerable as it is mounted on a long moveable arm. If this guide is bent accidentally, tape is misguided on its way into the scanner area. Always inspect all movable and stationary guides carefully and eliminate all causes of tape path error before attempting adjustments in the critical scanner area.

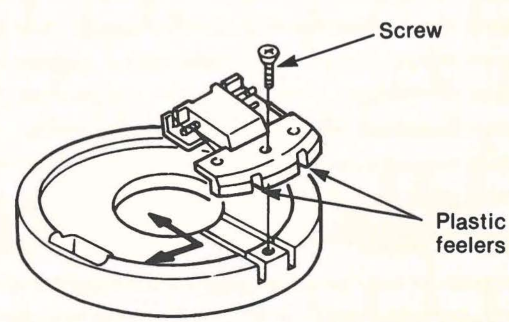


Fig. 15. Assembly on Betamax upper drum applies light pressure to top edge of tape.

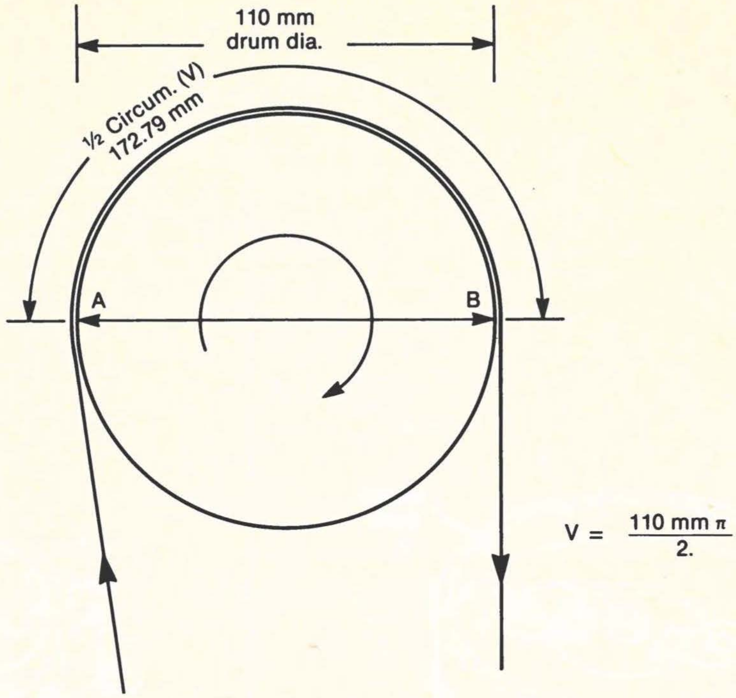


Fig. 16. Calculating ½ drum circumference.

2. WRITING-SPEED CALCULATIONS

We can calculate writing speed by finding the length of the video track and multiplying by the reciprocal of the time taken to scan that track.

Let's take the U-matic as an example and figure out the writing speed. We'll start with tape stationary and then refine matters to take into account the very small effect tape speed contributes.

The length of the stationary track is half the circumference of the scanner, as shown in Fig. 16. Because of overlap the recording extends for more than a half turn (180°). But the *effective* track is between the switching points, and this is 180° or half the circumference, and the trip takes 1/60th of a second. Let's refine this number, however, to take into account the time duration of a *color* field, which is 1/59.94 seconds.

The U-matic drum diameter is 110 mm. Multiply by π to get the full circumference, and then divide by 2 to get half the circumference. Half circumference = $110\pi/2$ = 172.79 mm. If we neglect tape speed and multiply 172.79 mm by 59.94 we get the distance traversed in one second: 10.35 meters per second.

Before we consider the effects of tape speed let's work out the basic triangle for stationary tape. Refer to Fig. 17. We have labeled the effective length of the track with 172.79 mm. The *helix angle*, the angle that the plane of the scanner makes with the reference edge of the tape, is 4° 54′49.1″. From this we can calculate the remaining two sides of the triangle.

$$\sin \alpha = \frac{w}{172.79 \text{ mm}}$$

where w is the effective width of the tape occupied by the video recording.

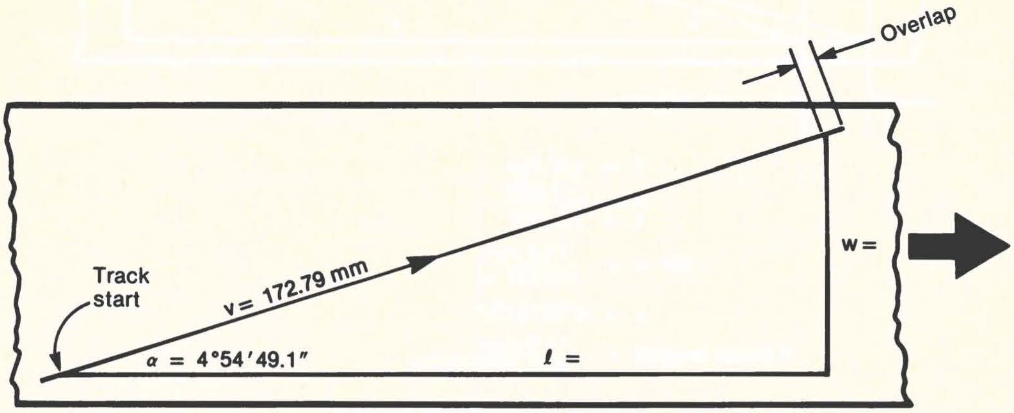
$$w = 172.79 \text{ mm} \times \sin 4° \, 54' \, 49.1''$$

This works out to 14.8 mm

The side parallel to the tape edge, ℓ, can be found by solving:

$$\cos \alpha = \frac{1}{172.79 \text{ mm}}$$

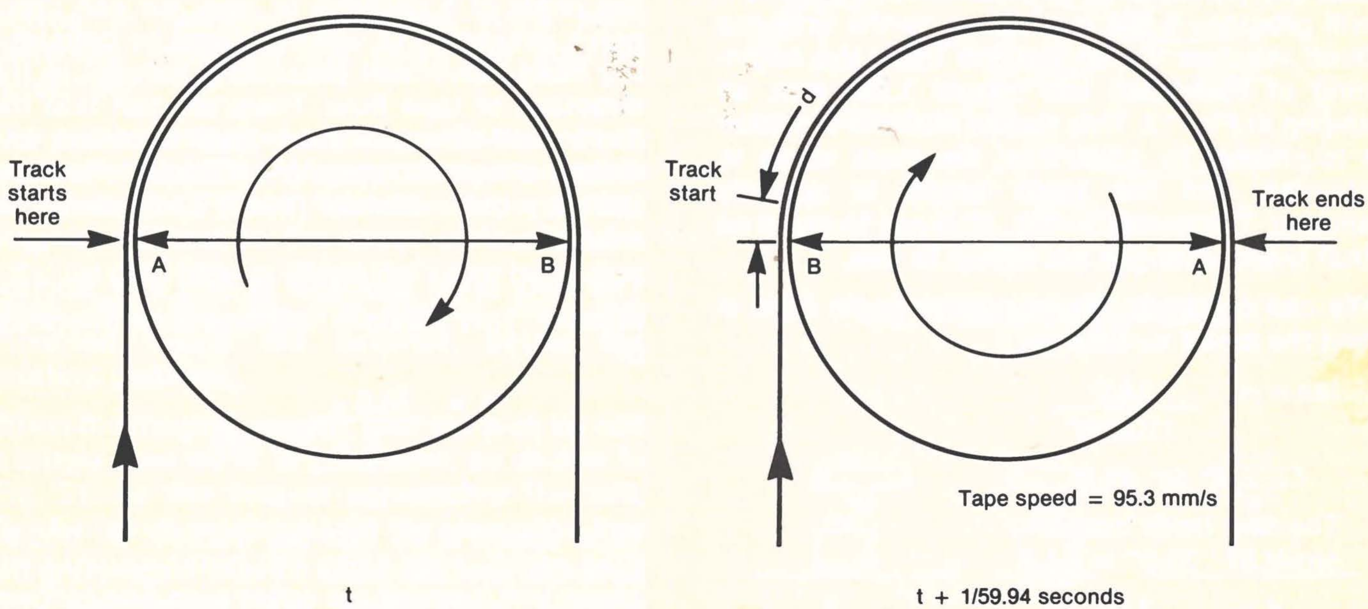
$$\ell = 172.79 \text{ mm} \cos 4° \, 54' \, 49.1''$$
$$\ell = 172.154 \text{ mm}$$



$$w = 172.79 \sin 4°54'49.1'' = 14.8 \text{ mm}$$

$$\ell = 172.79 \cos 4°54'49.1'' = 172.154$$

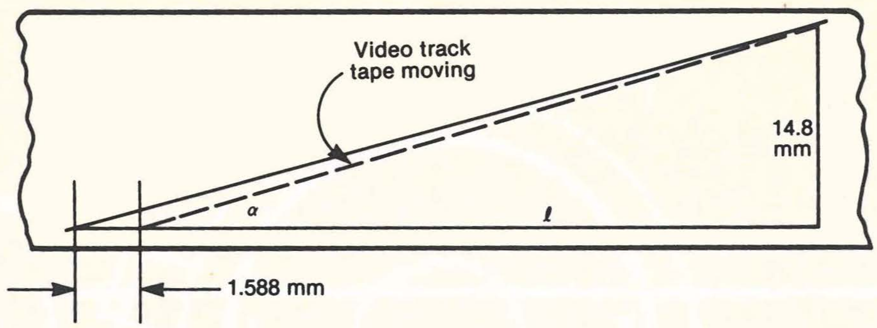
Fig. 17. Stationary tape triangle.



d = distance tape moves in 1/59.94 seconds

$$d = \frac{95.3 \text{ mm}}{59.94} = 1.588 \text{ mm}$$

Fig. 18. Start of track moves distance "d" in time taken for half turn.



$$\ell = 172.154 - 1.588$$
$$\ell = 170.567$$
$$\tan \alpha = \frac{14.8\text{ mm}}{170.567\text{ m}}$$
$$\alpha = 4°57'33.2''$$
$$V\text{ (track length)} = \frac{14.8\text{ mm}}{\text{sine } 4°57'33.2''}$$
$$V = 171.22\text{ mm (tape moving)}$$
$$\text{Writing speed} = 171.22\text{ mm} \times 59.94\text{ sec} = 10.26\text{ in/sec}$$

Fig. 19. Calculation of track angle & track length, tape moving.

Now let's get tape moving and see what changes. Refer to Fig. 18. During the time it takes for a video head to complete its swipe, tape moves in the same direction, some amount. Since tape moves in the U-matic at 95.3 mm per second, in 1/59.94th of a second it will progress 1.588 mm. Thus, by the time the head reaches the end of the track the beginning of that track has moved 1.588 mm, as shown in Fig. 19. This means that the distance ℓ is shorter by 1.588 mm, the track angle is steeper, and the track length is actually shorter. The sketch in Fig. 19 is not to scale so that these changes are easier to see.

We can calculate the new track angle from w and the new ℓ as follows:

$$\tan \alpha = \frac{14.8}{170.567}$$

$$\alpha = 4°\ 57'\ 33.2''$$

The new track length is:

$$\sin 4°\ 57'\ 33.2'' = \frac{14.8}{}$$

$$v = \frac{14.8\quad V}{\sin 4°\ 57'\ 33.2''}$$

$$v = 171.2\text{ mm}$$

Now, with tape moving, the video head traverses the shortened track in 1/59.94 seconds. This yields a writing speed of:

171.2 mm × 59.94 = 10261 mm/sec
or 10.26 meters per second

Quick-and-Dirty Figuring. With track angles on the order of 5 degrees or less, we can make quick estimates of writing speed by considering head movement practically parallel to the direction of tape flow. Then, we can find the drum half-circumference and subtract the distance tape moves in the time for one field. Let's try the industrial (1 Hr.) Betamax for an example.

The Beta drum diameter is 74.5 mm, approximately. This yields a half-turn circumference of:

$$v = \frac{74.5\,\pi}{2} = 117\text{mm}$$

Tape speed is 40 mm per second. In 1/59.94 seconds tape will move 0.7 mm. Neglecting the shallow track angle and subtracting this distance directly from v yields 117-0.7 = 116.3 mm. If we now multiply by 59.95 we get an approximate writing speed of 6.97 meters per second. The published writing speed spec for 1-hour Betamax is 6.973 meters per second.

3. TYPES OF PULSE GENERATORS

The scanner contains pulse-generators that produce timing pulses that signal the beginning of the swipe of each video head. In Sony machines the pulse generators are called PG (for pulse-generator) coils and the pulses produced are called PG pulses, usually 30 PG pulses in two-head machines since each generator produces one pulse per scanner revolution.

The pulse generators are magnetic and of two types: PM and EM. PM generators are used in the Betamax. These consist of permanent magnets affixed to the lower surface of the rotating platform on which the video head disc rests. See Fig. 20. The pick-up coils are mounted inside the scanner, below the rotating platform.

When the magnet sweeps over the pick up coil a single sine wave is generated, as shown in Fig. 21. As the magnet approaches the coil, flux builds up rapidly due to the expanding flux field induced into the coil's core. When both magnet and core piece are aligned, flux peaks but ceases to change. The field is neither expanding or contracting and induced voltage drops to zero. As the magnet sweeps away from the coil, induced core flux collapses and the negative going part of the wave results.

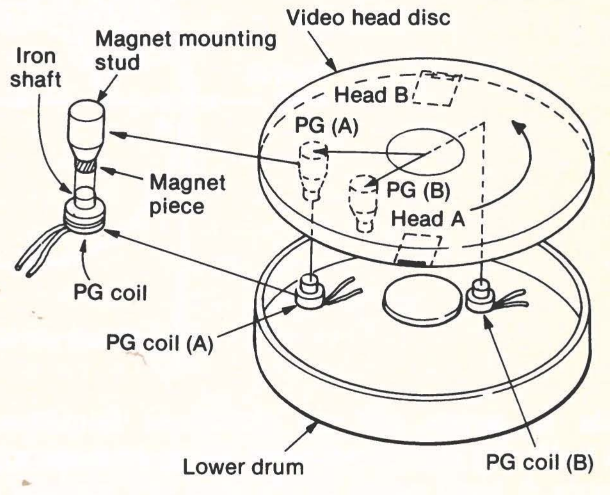


Fig. 20. PM-type pulse generators.

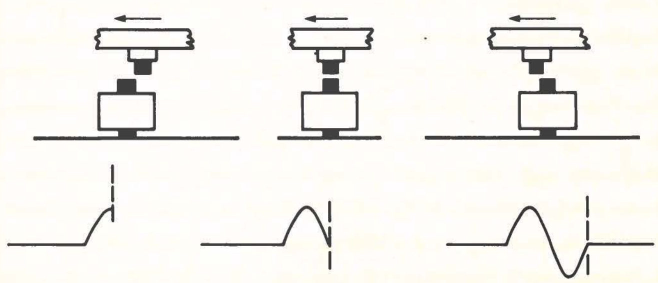
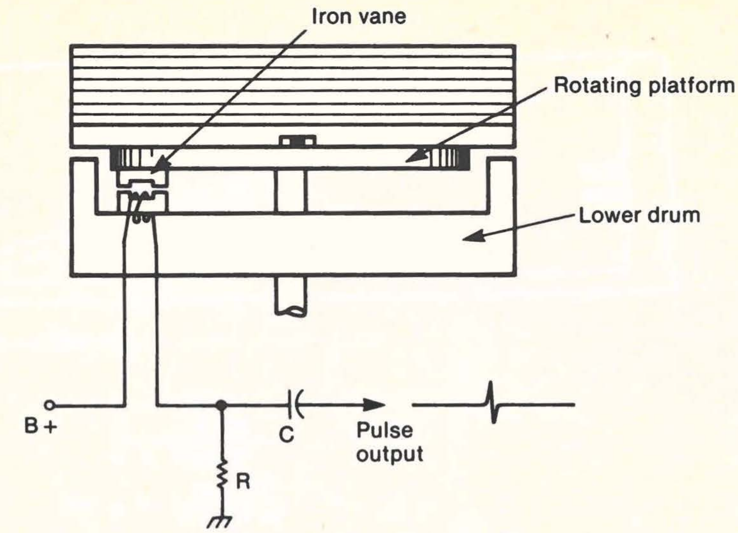
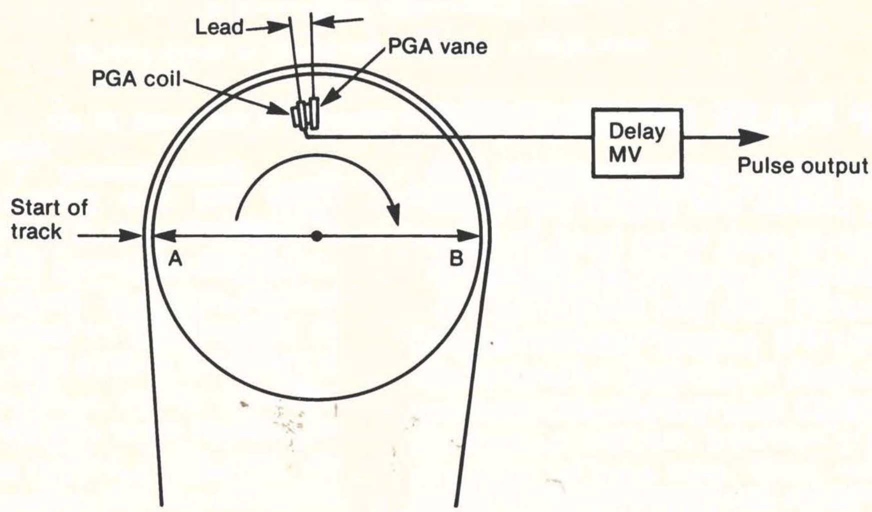


Fig. 21. Generating the single sine wave.



(a) EM-type pulse generator.



(b) PGA vane signals start of track.

Fig. 22. EM pulse generator for servo feedback.

The EM type pulse generator is found in many Sony VTRs. It is constructed as shown in Fig. 22(a). Direct current flows in the stationary coil, and when the moving iron vane is not lined up with the stationary core piece, the magnetic reluctance in the core piece is very high. As the iron vane comes into alignment with the stationary core piece the reluctance of the magnetic path drops sharply. Flux first expands, levels off as the vane comes into perfect alignment, and then drops as the vane moves away. The result is, again, a single sine wave, and is coupled out of the circuit by a capacitor.

The vanes (or magnets) and pick-up coils are placed so that a pulse is generated when the reference video head, called the *A head*, comes into position to start a video track. See Fig. 22(b). The signal so produced serves as timing information for the scanner servo system. The servo's job is to get the A head at the point on the track where vertical sync is recorded at the time when vertical sync appears in the signal being recorded. In the U-matic, for example, vertical sync appears 6.5 lines after the switching point. See Fig. 23. Add another three lines for overlap and we see sync about 9.5 lines from the actual start of the track. This means

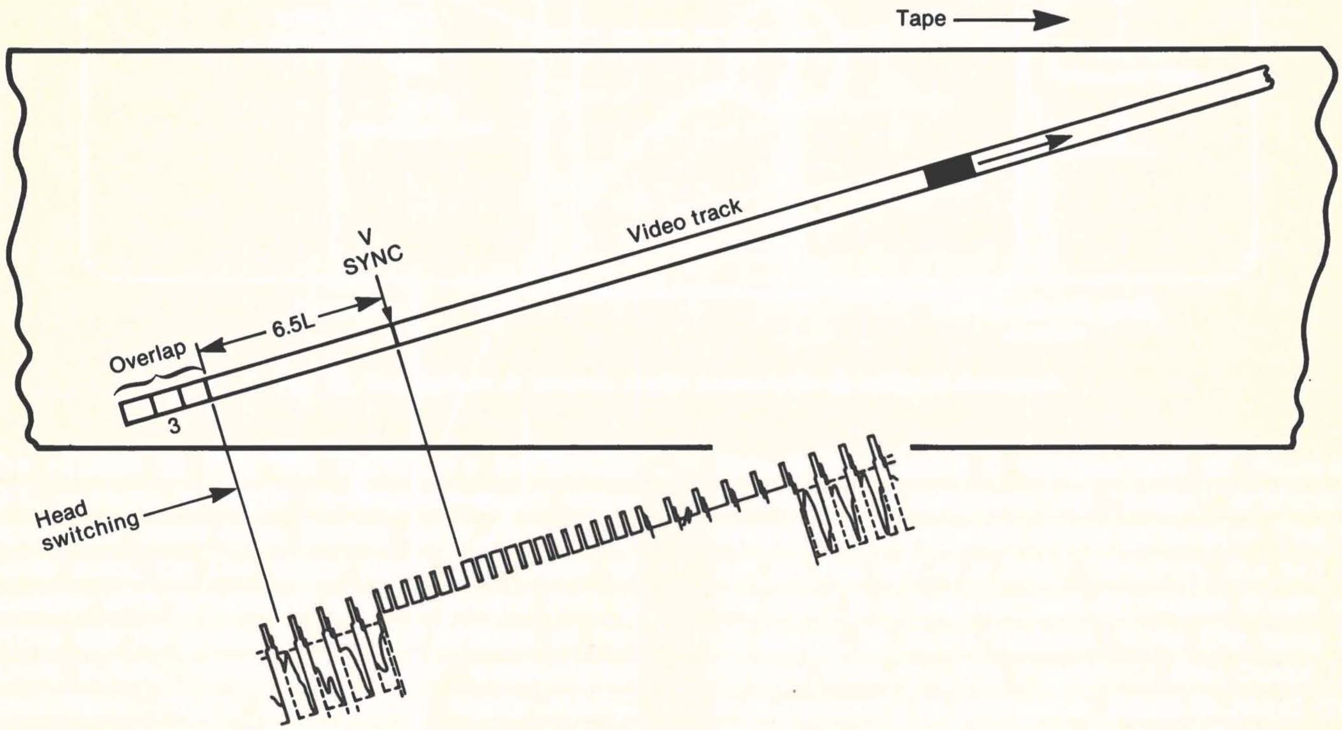


Fig. 23. Where SYNC appears on the U-matic track.

that the reference head should have contacted the tape and run up 9.5 lines of track at the instant the 30 PGA pulse is generated.

In practice the PGA pulse coil is positioned so that the 30 PGA pulse is generated earlier. The pulse is then shaped and applied to a delay multivibrator where a variable and adjustable time delay is inserted. This permits the final timing pulse to be trimmed electrically to the desired instant. In effect the multivibrator provides the equivalent of mechanical advance or retard of pulse-coil position. This provides electrical adjustment where mechanical adjustment would be extremely difficult. In many cases the pulse coils require removal of the rotating platform to gain access to the coils.

The pulse generated by the PGA coil serves as positional feedback for the servo. It also signals part of the head-switching job. That is, it signals the turn off of video head B signal and turns on the preamp for video head A.

A second pulse generator coil (30 PGB) performs the remainder of the head-switching job. It causes the head switching signal to flip so that the A head is effectively turned off and the B head turned on. In many machines the signal produced by the 30 PGB generator takes no part in the servo system and works only to establish half of the head switching signal. In late model U-matics the PGB signal does function in the servo system. The actual use of the PG pulse will be taken up in Lesson 6, dealing with servo systems.

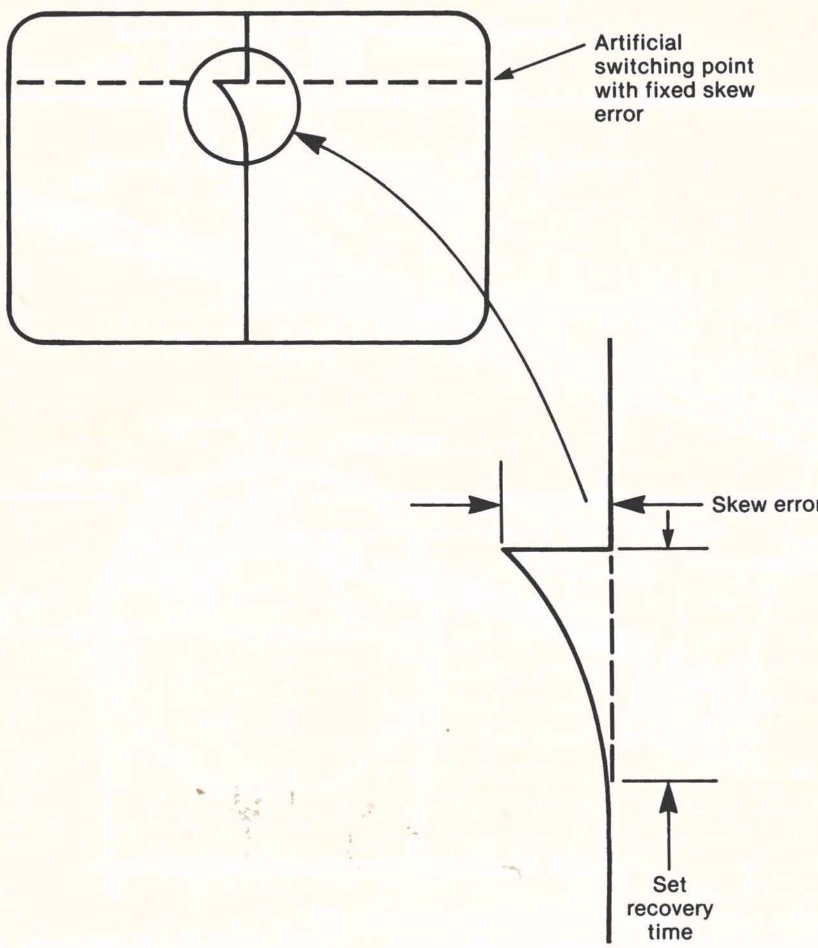


Fig. 24. TV set's HAFC action determines depth of "Flag" or bend.

4. IMPORTANCE OF HAFC IN THE TV SET

This section is not directly involved with scanners, but has to do with the visual symptoms produced by timing errors in the playback signal, particularly skew errors caused by variations in tape tension. You should be aware of the effect the TV set (or monitor) has on the visual effects of skew errors, why the TV set acts the way it does, how the choice of head-switching point was chosen to allow for TV set performance, and what can be done in the TV set to improve matters.

It has been general knowledge in our business that Sony Trinitron receivers as well as TV sets made by other Japanese manufacturers (who also make VTRs) show almost no effect at the top of the picture due to small amounts of skew error, dihedral error, or other forms of time-base error. Whereas American-made sets, at least those made before about 1977, showed considerable "flag waving" or flagging at the top of the picture when fed with the same VTR signal.

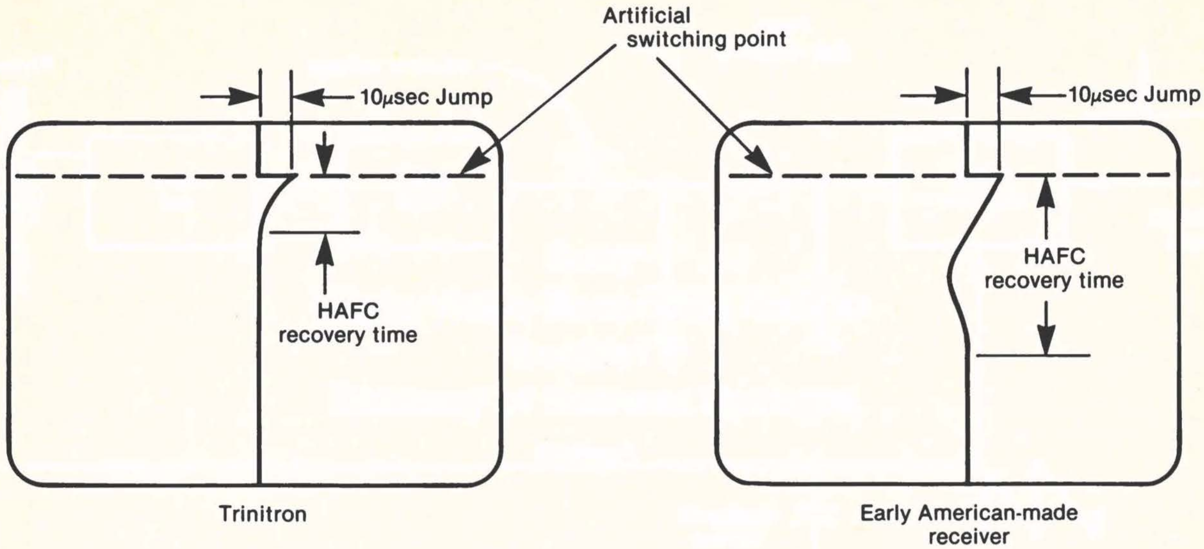


Fig. 25. Comparison of receiver HAFC recovery to an artificial skew error.

The reason is that the Trinitron's horizontal AFC system is made to recover much more rapidly to skew-type timing error. American made sets, on the other hand, are made to operate with broadcast signals where timing errors are no problem, but the effects of impulse noise, particularly under weak-signal conditions, might be. Hence, these HAFC systems are deliberately made to recover more slowly to timing errors and ignore the effects of random impulse noise (your wife's or daughter's hair dryer is a dandy impulse noise generator).

The effects of HAFC recovery time can be seen following the step or jump in timing that occurs at the head-switching point if skew error is present. Consider for a moment that an artificial skew error is generated near the top of the picture. That is, at some point, horizontal sync and video is made to advance or retard in time. If the video consists of a single vertical line, that line will show a displacement at the switching point, left if sync and video are advanced, right if retarded. Following the jump in timing the TV set's horizontal AFC system will catch up to the abrupt change in timing and the vertical-line in the picture will become vertical once more. Figure 24 shows this effect. The depth of the bend is the recovery time for the TV set's HAFC system.

Figure 25 shows a comparison of recovery times to a 5 microsecond "jump," artificially created with a special signal generator. The TV set on the left is a Sony Trinitron, the set on the right is a large-screen American made set of about 10 years vintage. Note the long recovery time and the overshoot that occur before recovery is complete. Keep in mind that this is not a comparison in overall sync performance. Reducing recovery time does adversely affect impulse-noise immunity to a degree. It should be observed, however, that since the advent of home videocassette machines, practically all manufacturers have taken steps to speed up recovery time.

To give the TV set as much time as possible to recover to skew-type errors, the head-switching point has been placed ahead of vertical sync (6.5 lines for the U-matic, for example). This puts the switching point at the very bottom of the picture, where it is least objectionable. It also gives the TV set the entire vertical blanking period for HAFC recovery. Hence, the horizontal oscillator should have settled down before the top of the picture begins. Where recovery time is slow (in some old sets a five microsecond error is followed by a recovery time of ⅓ to ½ a field); the top of the picture will bend or flag until recovery is completed.

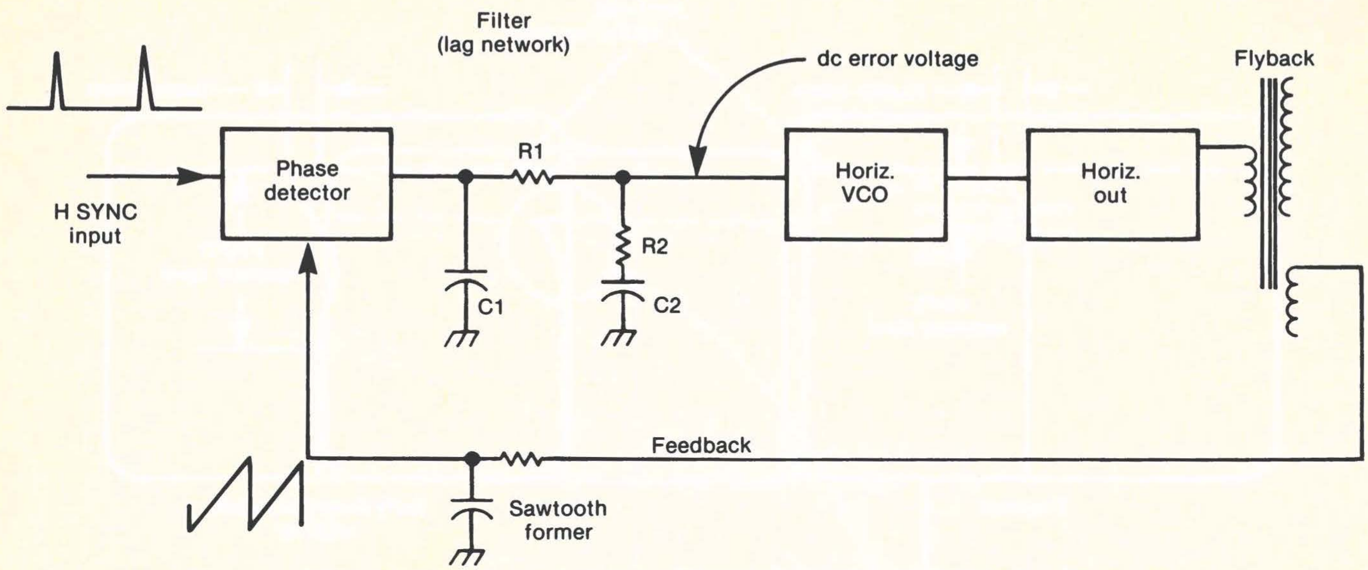


Fig. 26. Basic TV HAFC system.

The determining factor in the TV set's HAFC recovery is the time constant of the lag filter in the phase-lock loop used to control horizontal oscillator frequency. The basic system is as shown in Fig. 26. Separated horizontal sync is compared with a sample of oscillator output, usually obtained from a winding on the flyback transformer. This phase comparison produces a d-c error voltage whose polarity is determined by the direction of timing error and whose amplitude varies directly with the degree of error. The error or correction voltage is applied to the voltage-controlled horizontal oscillator to correct phase and frequency errors. The lag network in the signal path passes d-c, since C2 behaves as an open circuit. At higher frequencies, where C2 becomes a virtual short, the error voltage is reduced by the voltage divider action of R1 and R2. A long time constant for the R1-C2 combination makes the system ignore random noise pulses that may survive the sync separator. It also improves system stability because all negative feedback loops, such as this one, have sufficient phase shift at some frequency to cause feedback to become positive. TV techs are familiar with the "pie-crusting" symptom in the picture when the HAFC system oscillates, usually as the result of an open C2.

To speed up recovery time, C2 is made smaller, R2 is made larger, or both. Changes can be made on a trial and error basis but careful checks should be made to ensure that the system does not become unstable or that noise immunity is not totally destroyed.

Many manufacturers provide substitute HAFC plug-in boards for use when flagging complaints are received (often from cable TV subscribers where helical-scan VTRs may be used as program sources).

An interesting footnote is the intentional extension of recovery time for certain video monitors. In some cases recovery time is made very long, such as a full field interval following a 10 microsecond jump in sync timing. Such a monitor can not recover from timing errors and displays all forms of time-base error. Monitors modified in this way are used to evaluate time base error on the VTR production line.

Take the time to review the material in this booklet and look at the tape once more to consolidate what you have learned about the scanner. Then, fill out the self test at the end of this booklet and check your answers.

Sony
Basic Video Recording Course
Booklet 3
Glossary of Scanner Systems

Alpha Wrap—A complete overlapping turn of tape around the video head drum in a path shaped in the form of the Greek letter alpha (α); allows use of a single head.

Audio Track—The portion of the magnetic tape on which audio information is recorded with a stationary head, in the longitudinal direction.

Azimuth—The angle, measured clockwise, from the perpendicular formed by the gap in the head and the direction of the track across the tape.

Control Track—The portion of the magnetic tape on which control pulses for timing signals are encoded, using a stationary head.

Dihedral Error—In a two-head video system, the error which results from the two heads not being exactly 180°.

Drop Out—A discontinuity in the video signal caused by dirt or grease or lifting of the video tape from the head.

Entrance Guide—A stationary tape guide at the input side of the scanner, which controls tape height and angle with respect to the scanner.

Gap—The space between the two magnetic poles of a tape head.

HAFC—Horizontal Automatic Frequency Control system; a system which automatically maintains the horizontal oscillator frequency within set limits.

Head Drum—The rotary mounting plate on which video heads are placed, in order to achieve high writing speeds.

Head Switching—The process of switching between video heads in a multiple head video recording system.

Helix Angle—The angle which the plane of the scanner makes with the reference edge of the tape.

Non-segmented—Video recording system in which each pass of a video head is a complete field.

Omega Wrap—The method of threading tape around the video head drum in an almost complete circular path, shaped in the form of the Greek letter omega (Ω).

***Overlap*—**The part of a video track which is recorded both at the end and beginning of two successive video tracks.

***Pulse Generator*—**The device which produces timing pulses as the head drum rotates, used in the video head servo sync system.

***Quadraplex*—**A four-part segmented video recording system which uses four video heads (often called "quad").

***Rabbet*—**The shelf or shoulder of the lower video head drum surface which serves to guide the tape around the scanner.

***R-F Envelope*—**An oscilloscope display of the curve formed by the peaks of a signal and showing the waveform of a modulated radio-frequency carrier signal. (In VTRs, the signal at the video heads, or "off-tape" video.)

***Scanner*—**The mechanism, comprised of the head drums and rotating video heads, which passes over the videotape to record or playback the video tracks.

***Segmented*—**A video recording system in which each pass of a video head across the tape deposits a fraction of a field. (More than one pass is required to record a complete field.)

***Skew Error*—**Error in which the horizontal sync and video is advanced or retarded from normal timing.

***Sync Head*—**The head in a so-called "1½ head" video recording system that records information only during the vertical blanking period.

***Time Base Errors*—**The mechanically induced timing errors present in a video tape recording system; these are due to incorrect tape tension, tape stretch, differences between machines, etc.

***Video Head*—**A magnetic recording transducer which deposits or reads magnetically encoded video information on video tape.

***Video Track*—**The portion of the magnetic tape on which video information is recorded with a rotating head, in a diagonal position.

***Wrap Angle*—**The angle which the tape makes against the scanner surface, measured from the center of the scanner.

SONY
BASIC VIDEO RECORDING COURSE
SELF TEST NO. 3
SCANNER SYSTEMS

1. In modern VTRs, signal is coupled into and out of the rotating video heads via: (a) slip rings; (b) capacitive coupling; (c) a commutator; (d) a rotary transformer.
2. Systems that employ two video heads, wherein the heads record alternate fields, employ a head disc that spins at approximately: (a) 30 revolutions per second; (b) 60 revolutions per second; (c) 90 revolutions per second; (d) 3600 revolutions per minute.
3. The wrap angle in the U-matic is: (a) less than 180°; (b) more than 180°; (c) precisely 180°; (d) 360°.
4. Scanners in halical-scan VTRs that employ a single video head rotate at: (a) 1800 rpm; (b) 900 rpm; (c) 30 rps; (d) 60 rps.
5. The 30 PGA pulse in the U-matic scanner is generated: (a) shortly before the head switching point; (b) 60 times per second; (c) at the end of the video track; (d) after vertical sync has been recorded.
6. An error in the distance between the scanner and the control-track lead, as measured along the tape route, results in: (a) mistracking and a degradation of signal-to-noise ratio; (b) loss of servo synchronization; (c) excessive skew error; (d) mistracking when the machine is playing back its own recordings.
7. The symptom wherein vertical lines in the picture split into a symmetrical "V" at the switching point is the result of: (a) mistracking; (b) skew error; (c) dihedral error; (d) a defective PG coil.
8. A two-head scanner similar to the Betamax has a drum diameter of 50 mm and a tape speed of 30 mm per second. The approximate writing speed is: (a) 6.92 meters per second; (b) 5.57 meters per second; (c) 10.4 meters per second; (d) 4.68 meters per second.
9. Segmented VTRs employ head wheels that rotate at speeds: (a) above the field rate; (b) below the field rate; (c) at the field rate; (d) at half the field rate.
10. Skew error results from: (a) error in rotational speed; (b) video-head dihedral error; (c) excessive take-up torque; (d) too much or too little tape hold-back tension.
11. To ensure a continuous, unbroken TV playback signal in two-head machines, the signal is recorded ahead of and following the head switching point to provide a total overlap interval of: (a) six TV lines; (b) one TV field; (c) 4.76 microseconds; (d) 30 microseconds.

12. The symptom wherein vertical lines in the picture appear to flag to the left or right just below the head-switching point is the result of: (a) dihedral error; (b) loss of servo sync in the record mode; (c) tracking error; (d) back-tension error.
13. The PG coil develops an output signal that looks like: (a) a positive pulse; (b) a negative pulse; (c) a single sine wave; (d) a differentiated square wave.
14. In some VTRs the upper rotating drum is made larger in diameter than the lower drum to: (a) minimize friction; (b) introduce an air bearing; (c) force the tape down against the guide rabbet; (d) increase writing speed.
15. All Sony VTRs employ: (a) the omega wrap; (b) the alpha wrap; (c) scanners having the same drum diameters; (d) identical tape speeds.
16. The scanner-derived signal that serves as timing feedback for the servo system in most Sony machines is developed by the: (a) control track head; (b) sync separator; (c) 30 PGA coil; (d) 30 PGB coil.
17. When the moving vane in a EM pulse-generator becomes aligned perfectly with the coil core piece, coil output is: (a) rising; (b) maximum positive; (c) maximum negative; (d) zero.
18. In the Sony Omega VTR the sync head is: (a) half the thickness of the video head; (b) 180° from the video head; (c) identical to the video head; (d) a stationary head mounted on the lower scanner surface.
19. When a Betamax or U-matic VTR is switched from the still (or pause) mode to normal play speed, the video track: (a) becomes shorter; (b) becomes longer; (c) stays the same in length; (d) makes a shallower angle with respect to the lower edge of the tape.
20. The visual effects of time-base error are more evident in monitors wherein the HAFC system employs a: (a) short time-constant filter in the output feed from the phase detector; (b) long time-constant filter in the input feed to the VCO; (c) noise-protected sync separator; (d) error-voltage filter that gives a low degree of impulse noise immunity.

Answers:

1. (d)	6. (a)	11. (a)	16. (c)
2. (a)	7. (c)	12. (d)	17. (d)
3. (b)	8. (d)	13. (c)	18. (c)
4. (d)	9. (a)	14. (c)	19. (a)
5. (a)	10. (d)	15. (a)	20. (a)

SONY®
Video Products Company

Published by
VIDEO TECHNICAL INFORMATION
700 WEST ARTESIA BLVD., COMPTON, CA 90220